16th EUROPEAN CONFERENCE

TECHNOLOGICAL INNOVATIONS
IN REFRIGERATION AND IN AIR CONDITIONING

organised by
Centro Studi Galileo and
Associazione dei Technici italiani del Freddo

Politecnico of Milan 12th – 13th June 2015

Energy savings and Environmental issues
Results and updates in new systems

NATURAL REFRIGERANTS

ENERGY SAVING
90° C hot water NH3 heat pumps
In DAIRY PLANTS

presentation by : Jan Boone - MAYEKAWA EUROPE nv

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"Natural Five" Refrigerants and Product Solutions

Refrigerant (Natural Five)	NH_3 R-717	CO_2 R-744	HC Hydrocarbon	H_2O R-718	Air R-728
90℃ / 60℃ / 10℃ / -15℃ / -25℃ / -40℃ / -50℃ / -60℃ / -100℃	Utility hot water Chilled water Ice making Cold storage, Freezer, Fish boat **Specific Refrigeration needs** Freezer, Freeze-dry, Super Low temp storage	Utility hot water Chilled water Ice making	Utility hot water Heating HVAC Cryogenics	Heat recovery Chiller	Cryogenics
Notes	·Conventional system ·National Projects	·Eco-Cute	·Nat'l Proj. ·Butane + Propane	·Nat'l Proj. ·Adsorption ·Heat recovery	·Nat'l Proj. ·Air-cycle

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COMBINED NH3 CHILLER / HOT WATER HEAT PUMP

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FIELD CASE

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INTRODUCTION

STARTING POINT	
2 Mw 1,5°C 3 Mw 90°C max.	Chiller units to produce 2000 kW (MASTER function) contractor : SVEDAN INDUSTRI DENMARK Hot water heat pump 3000 kW using chiller heat rejection as heat source (SLAVE function)
CHOICE	NH3 2 stage reciprocating compressor system 2 sets of each 1000kW chilling & 1500kW heating complete factory produced modules with minimum site works using N8M 30 bar piston for the chiller using N6HS 66 bar piston for the heat pump
TIME FRAME	start up February 2014.

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OVERCOMPRESSION HOT WATER HEAT PUMP

SPECIFICATION OF UNIT

		UNIT 1	UNIT 2	TOTAL
CHILLER PART				
Cooling Capacity	[kW]	1030.1	1030.1	2060.2
Evaporative Temperature	[C]	0.0	0.0	
Inlet Water Temperature	[C]	10.0	10.0	
Outlet Water Temperature	[C]	1.5	1.5	
Intermediate Temperature	[C]	45.0	45.0	
HEAT PUMP PART				
Heating Capacity	[kW]	1452.6	1496.0	2948.6
Condensing Temperature	[C]	81.0	92.0	
Condenser				
Inlet Water Temperature	[C]	67.1	78.7	
Outlet Water Temperature	[C]	78.7	90.0	
Liquid Sub Cooler				
Inlet Water Temperature	[C]	65.0	65.7	
Outlet Water Temperature	[C]	65.7	67.1	
C.O.P cooling	[-]	4.22	4.22	4.22
C.O.P heating	[-]	7.49	5.99	6.64

Total Cooling capacity : 2060 kW
Outlet water temperature : 1.5 C

Total Heating capacity : 2950 kW
Outlet water temperature : 90 C

NATURAL REFRIGERANTS

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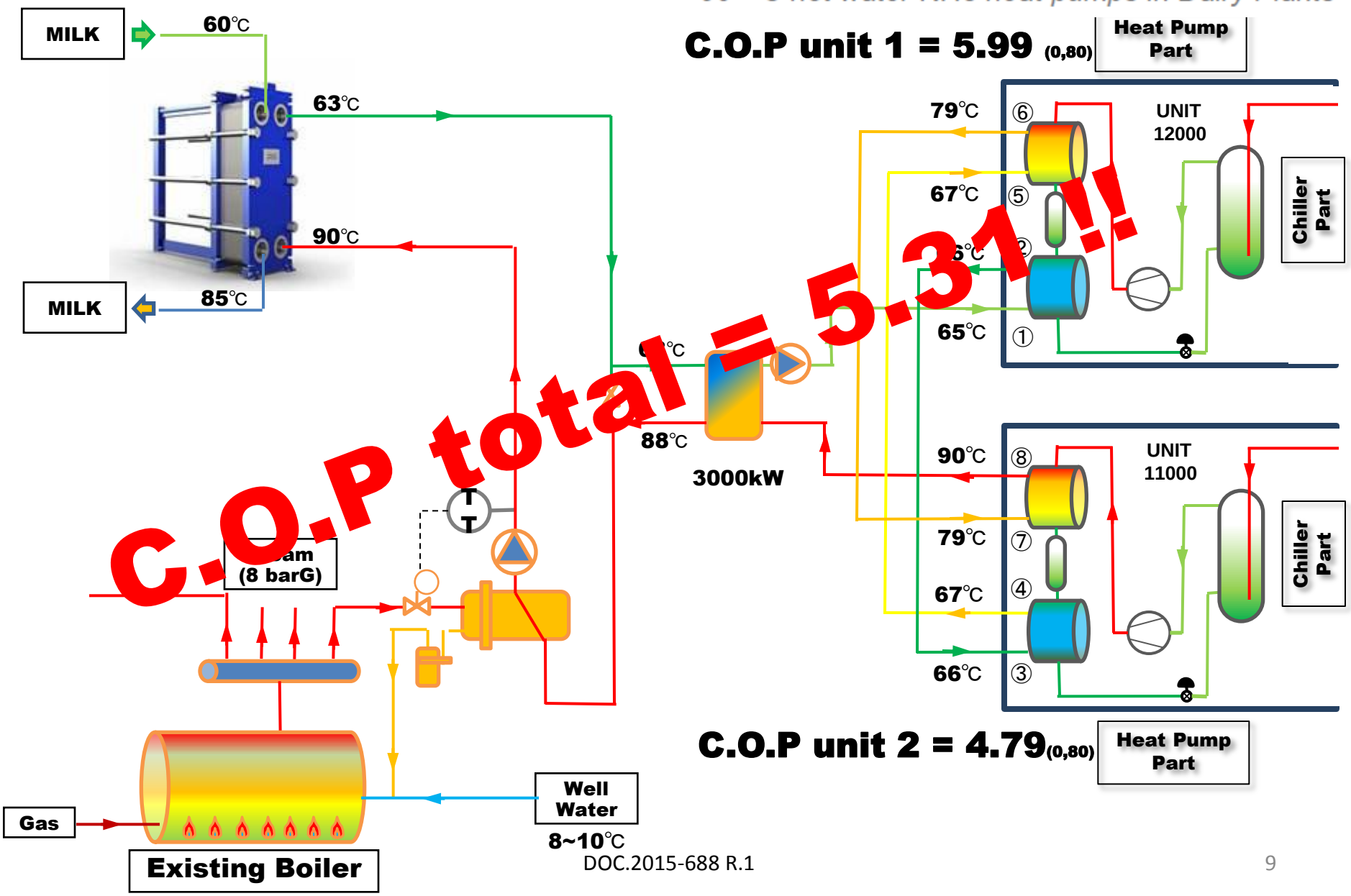

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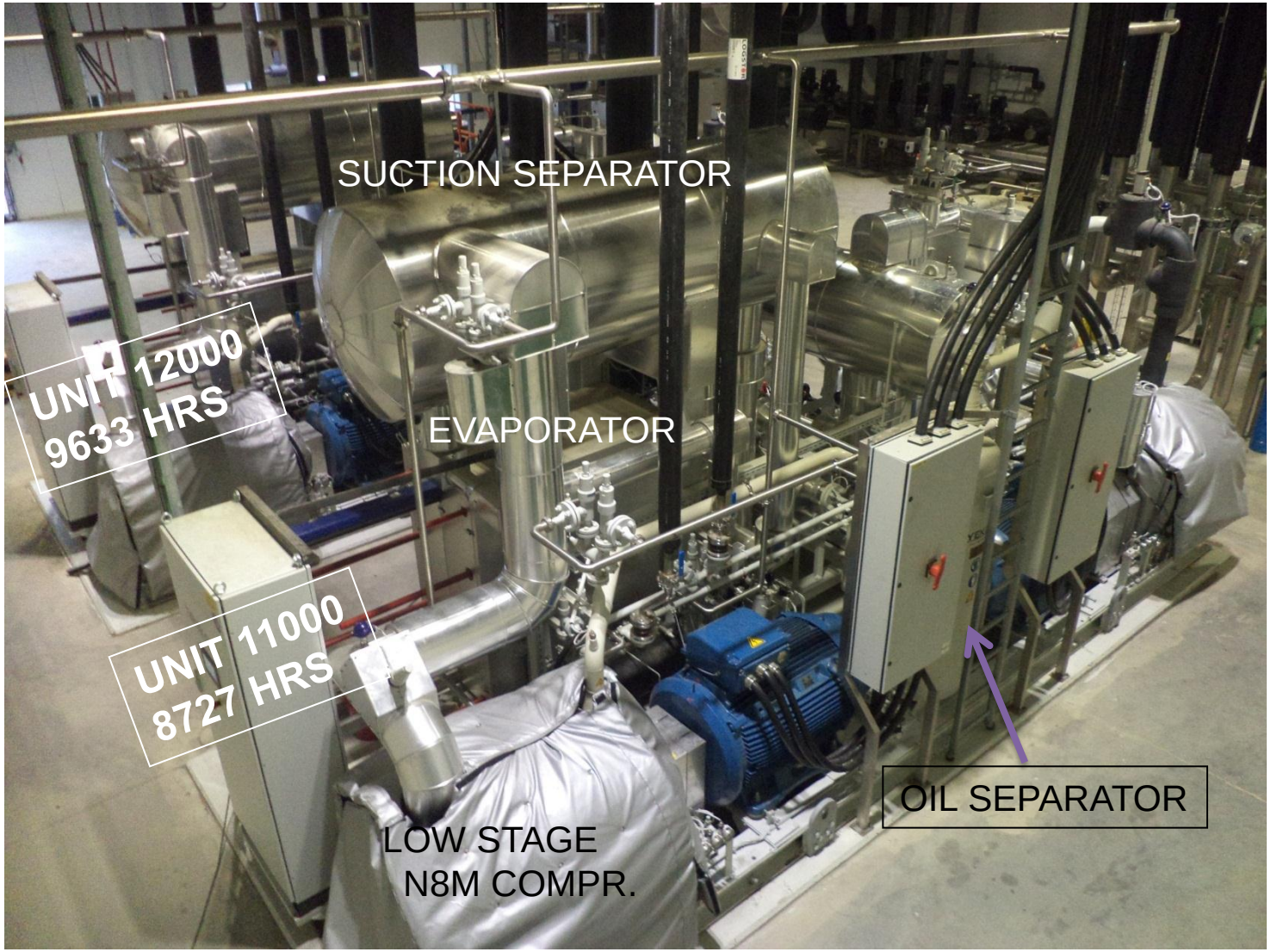

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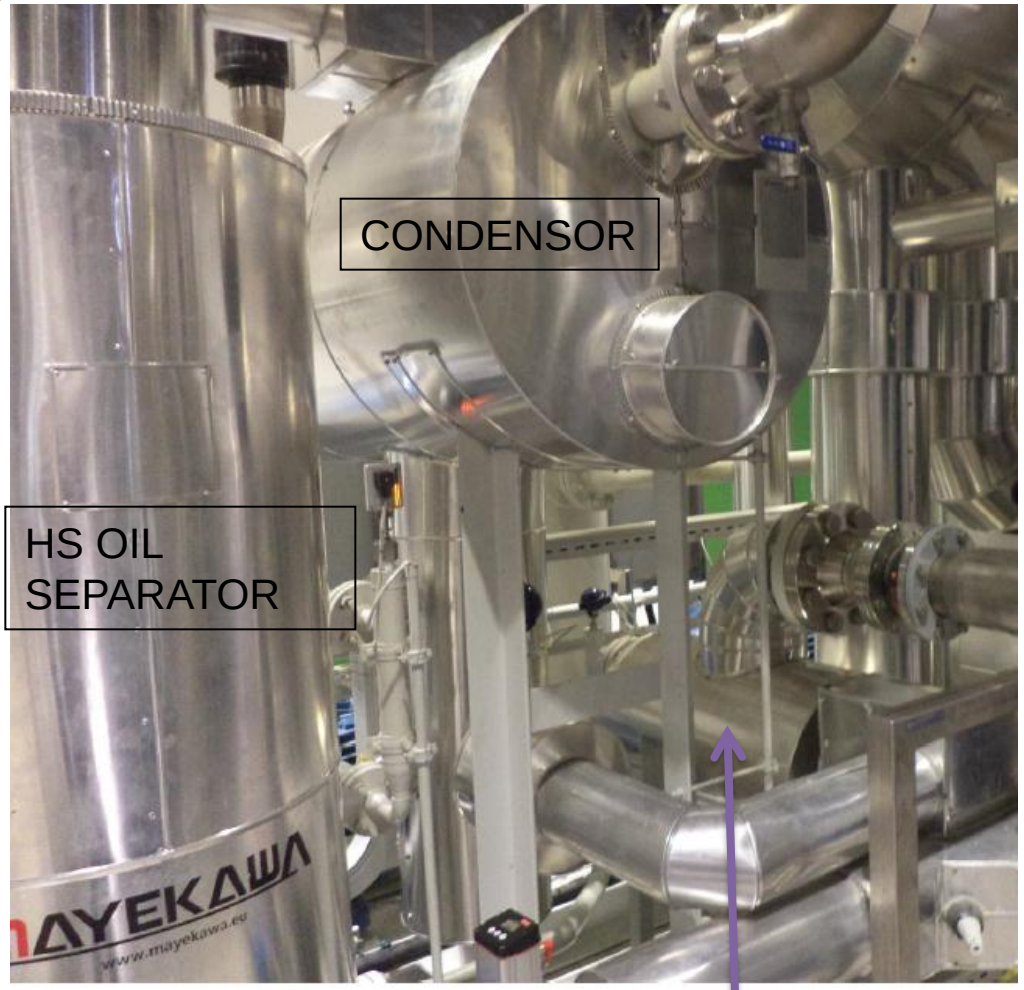
N6HS HIGH STAGE COMPRESSOR



HEAT SOURCE FLASH TANK

LIQUID SUBCOOLER

NATURAL REFRIGERANTS

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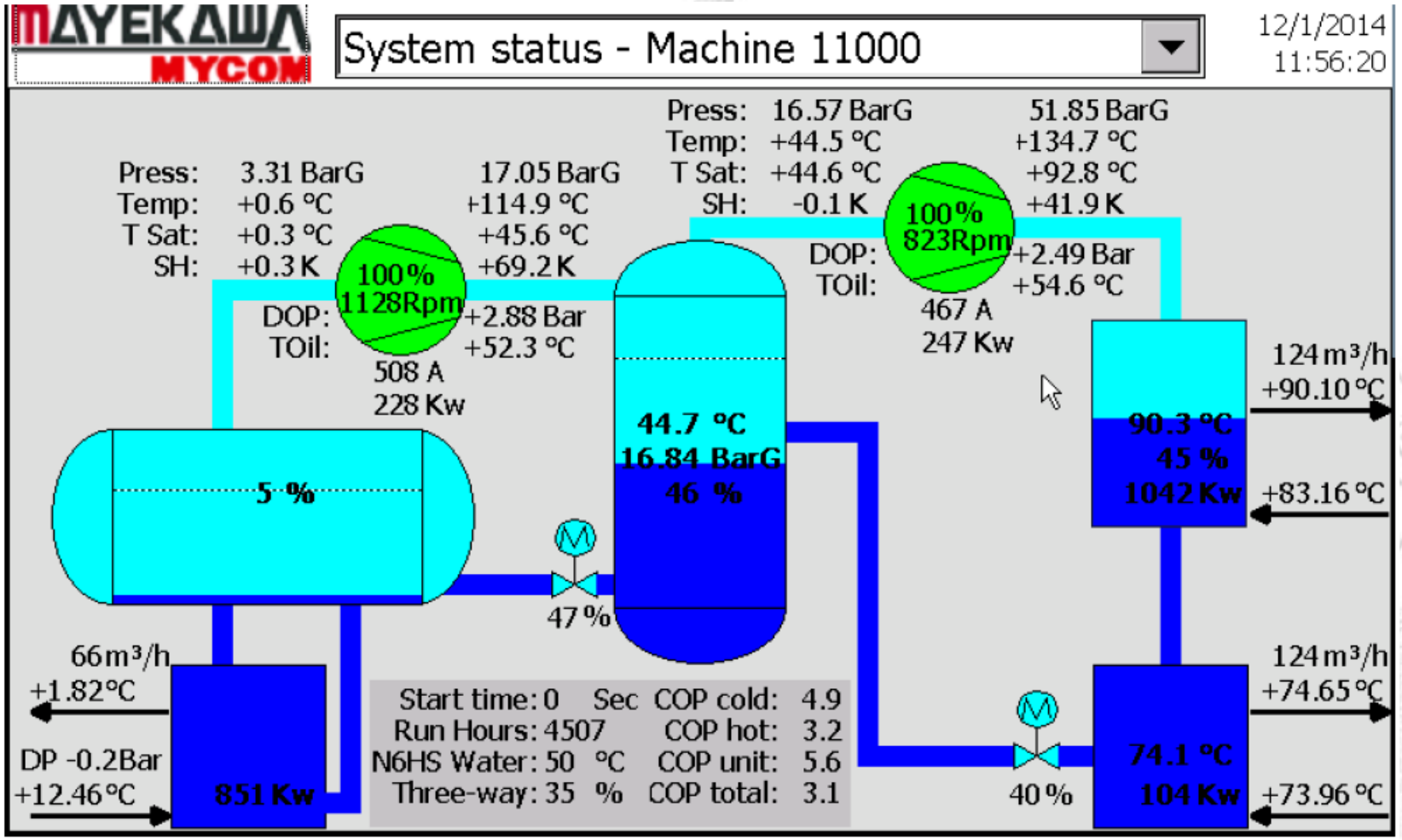

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MERIT of HIGH STAGE HEAT PUMP

Gas Boiler

Heating capacity (day)	kWh/day	58,972
efficiency of boiler	-	0.85
Heating Capacity	kWh/day	69,378
Unit Price	€/kWh	0.064
Comsumption(year)	kWh/yr	21,507,296
Running cost (day)	€/day	4440.2
Operating days	day/year	310
Running cost(year)	€/year	1,376,462

High Stage Heat Pump

Heating capacity	kW	2948.6
Running time (day)	hrs/day	20.0
Break kilowatto(/0,75)	BkW	592
Power Comsumption(day)	kWh/day	11.840
Heating capacity (day)	kWh/day	58972
Unit price	€/kWh	0.1
COP		4.97
Consumption(year)	kWh/year	3.670.000
Running cost(day)	€/day	1.184
Operated days	day/year	310
Running cost(year)	€/year	367.040
Merit (vs GAS Boiler)	€/year	1.009.422

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High Stage Heat Pump

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Break kilowatto(/0,7[illegible])	kW	592
Power Comsump[illegible]ion(da[illegible])	kWh/day	11.840
H[illegible]ating capacity (day)	kWh/day	58972
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EXPECTED MERIT : 1 M€/year

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CONCLUSION

1	NATURAL REFRIGERANTS ARE THE MAIN TREND FOR INDUSTRIAL REFRIGERATION AND -HOT WATER PRODUCTION IN FOOD INDUSTRY. TO-DAY HOT WATER TEMPERATURES OF 90°C ARE ACHIEVABLE.
2	THE FIELD CASE SHOWS OPERATING HOURS COVER THE DESIGN. ALTHOUGH 2 YEARS OPERATION IS REQUIRED FOR FINAL ANALYSIS OF THE PACKAGES.
3	POSSIBLE BARRIERS : NH3 AT HIGH PRESSURES LUBRICATION OIL CHOICE AND QUALITY EQUIPMENT SUITABILITY OPERATION FINETUNING CONTINUOUS SUPERVISION

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Many thanks for your attention

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